Fuel Modification to Facilitate Future Combustion Regimes?

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Question

- **Can new fuels, or modifications to fuel composition, promote the achievement and expansion of operating regimes for advanced combustion technologies, such as LTC?**

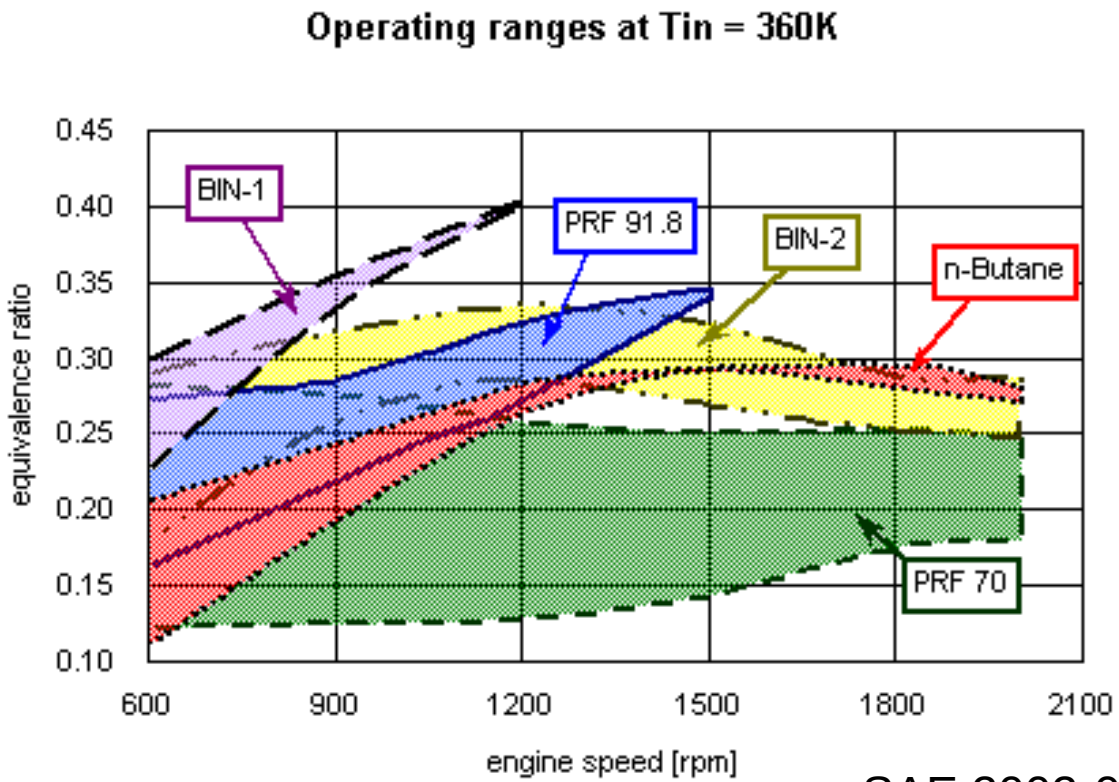
My answer: I think so!

Simplified Global Statements

- **Key to LTC:**
  - **Achieve appropriate mixing of fuel and oxidizer prior to the ignition chemistry progressing to auto-ignition, which is to occur within some designated time during the cycle**
- **Many different scenarios have been proposed for achieving this**
  - **HCCI, PPC, MK, DCDC, CAI, …**
- **These different scenarios are really different approaches to mold the engine operation around the fuel's physical and auto-ignition characteristics**

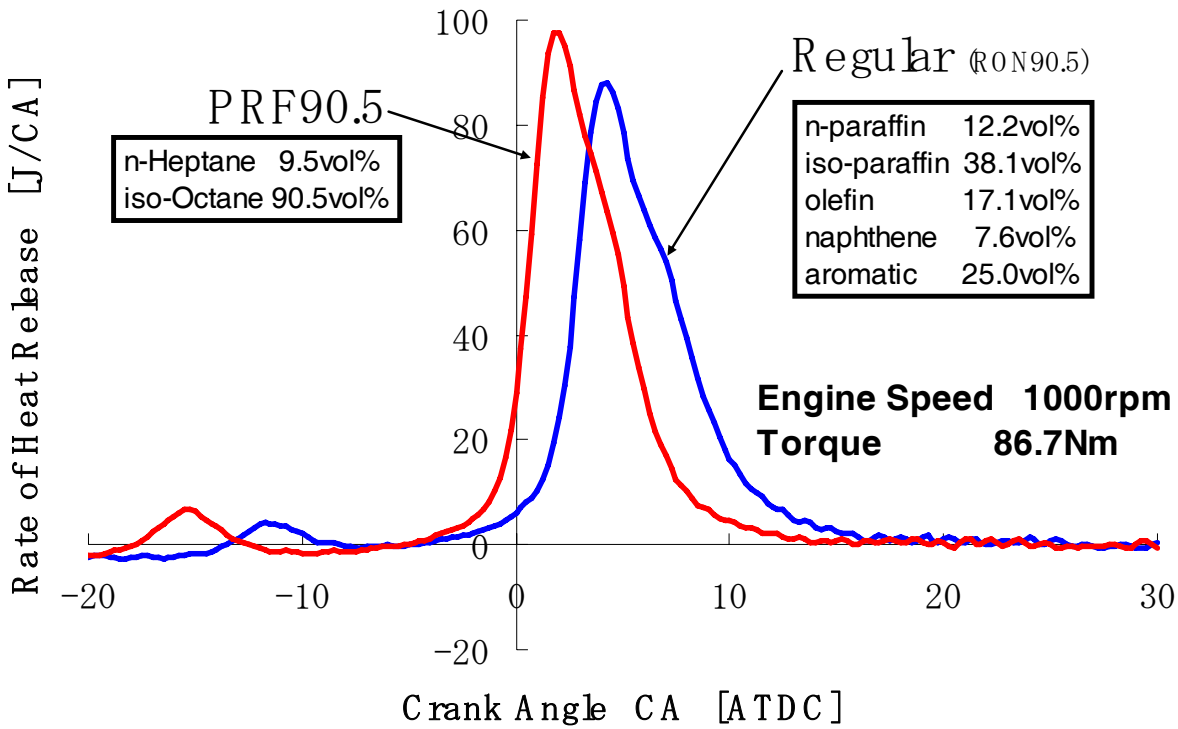
Background

- LTC is controlled by ignition kinetics
- Ignition kinetics are dependent on fuel composition



SAE 2002-01-2830

Correlation between Chemical Composition and LTHR



Even in the case of same Research Octane Number Fuels, the heat release rates are different because of…

(1) The LTHR characteristics of paraffins

(2) Inhibitor effects of aromatics and some naphthenes and olefins

SAE 2005-01-0138

Correlation between Chemical Composition and HTHR

HTHR CA50 = G(LTHR CA50, LTHR heating value)

Low Temperature Heat Release
- LTHR CA50
- LTHR Heating Value

G

High Temperature Heat Release
- HTHR CA50

$(dp/d\theta)_{max}$ vs HTHR:Linear

COV_{IMEP}% vs HTHR: Quadratic

F

K(F,G)

Fuel Composition
- **Fuel Chemicals**
- **HC types**

Engine Performance
- Maximum $dp/d\theta$
- COV_{IMEP}%

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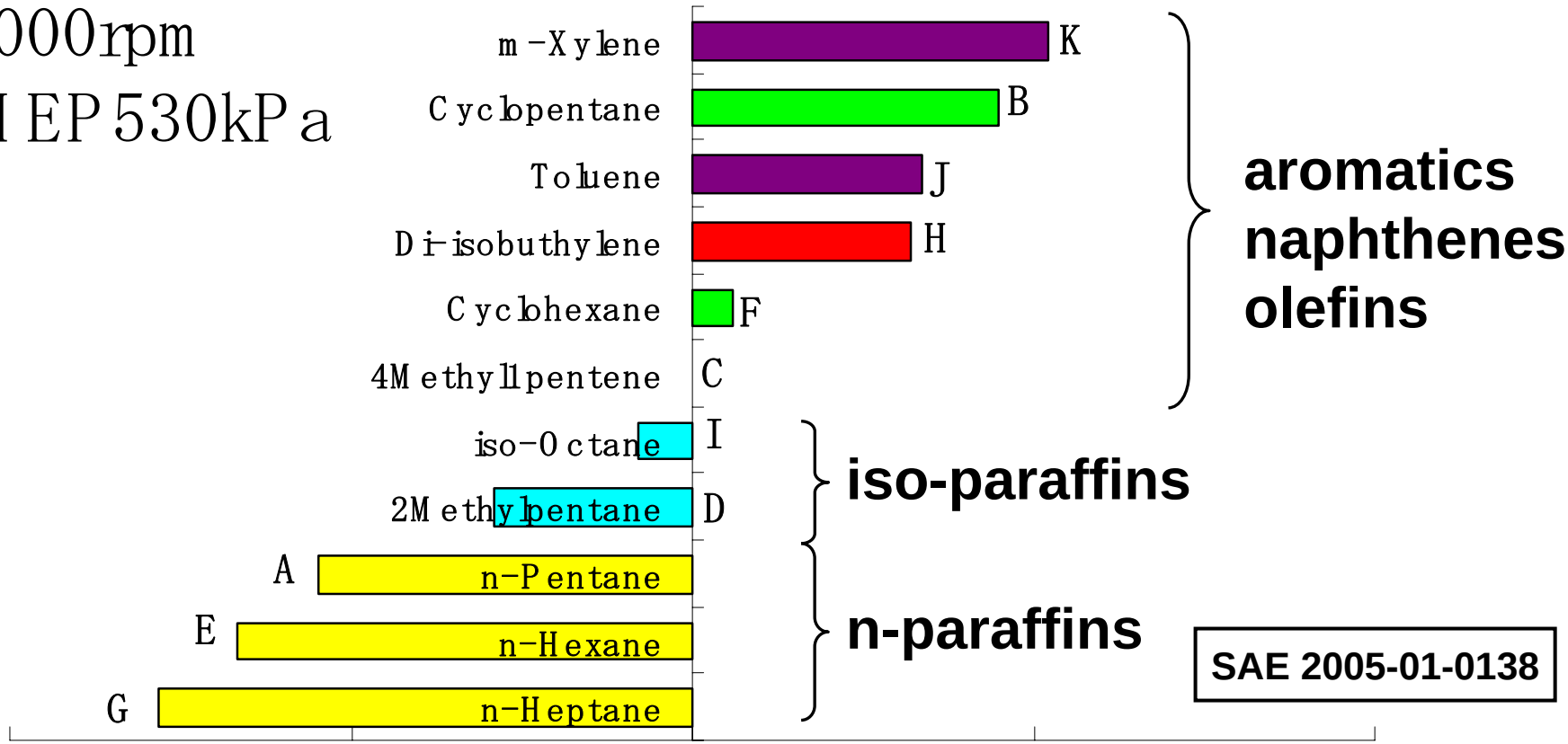
Correlation between Chemical Composition and HTHR

1000rpm
IMEP 530kPa



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Chemicals that advance HTHR ← **HTHR** → **Chemicals that delay HTHR**

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- LTHR Heating Value

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High Temperature Heat Release
- HTHR CA50

$(dp/d\theta)_{max}$ vs HTHR:Linear

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F

Advance HTHR

n-paraffins
iso-paraffins
olefins
naphthenes
aromatics

Fuel Composition
- **Fuel Chemicals**
- **HC types**

ne Performance

um $dp/d\theta$

- COV_{IMEP}%

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Ultimately, achieving LTC is a combination (matching) of engine technology and fuel chemistry

Proposed Fuel and Engine Characteristics for Versatile LTC Operation

- **Engine Characteristics**
  - **Valve train flexibility**
  - **Direct Injection, advanced injection capabilities**
  - **Intake charge cooling**
  - **…….**
- **Fuel Characteristics**
  - **Moderate to high volatility**
  - **Low Cetane number**
  - **Low Octane number**

Can these characteristics be tailored through the appropriate blend of naphthenes, olefins and iso-parafins?

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